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ABSTRACT

Middle school children make a number of accomodations that create stress in their lives. This study examined the effects on sixth and seventh grade students (N=53) of a stress management program that emphasized self-regulation of physiological aspects of functioning along the relaxation/arousal continuum. The experimental group received intensive training in self-regulation for 7 weeks during the physical education period and then practiced the skills periodically throughout the school year. At the completion of the training period for self-regulation, both the experimental group and the control group engaged in a thinking skills program as part of the regular language arts period. The students in the self-regulation training were impressively successful, as measured by peripheral temperatures, in changing their levels of arousal or relaxation with the assistance of the trainer. On their own, students continued to be successful in relaxing, but failed to master the skill of eliciting the arousal response at will. Throughout the thinking skills program, the experimental group tended to score higher on teacher-made tests than did the control group, but they failed to outperform their counterparts on a standardized test of higher-order cognitive abilities. The treatment tended to diminish significantly perceived anxiety levels and to improve perceptions of students about themselves. (Author/ABL)

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A STUDY OF THE EFFECTS OF A STRESS MANAGEMENT PROGRAM ON AFFECTIVE AND COGNITIVE MEASURES OF MIDDLE SCHOOL CHILDREN

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Mrs. Griggs organized all of the instructional materials, composed the nine achievement tests, and assisted in the administration of some of the standardized instruments after instruction ended. Mrs. Beulah El-Amin worked with the Principal Investigator in the eustress training. She was responsible for accompanying students to the laboratory room for the self-regulation training. Also, she was responsible for placing biofeedback equipment and all materials that would be needed during each session on tables for use by the students. Mrs. El-Amin assisted, furthermore, with the administration of the standardized tests that would provide the data for analysis.

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ABSTRACT

Sixth and seventh grade children participated in a stress management program that emphasized self-regulation of physiological aspects of functioning along the relaxation/arousal continuum. The experimental group received intensive training in self-regulation for seven weeks during the physical education period and then practiced the skills periodically throughout the school year. At the completion of the training period for self-regulation, both the experimental group and the control group engaged in a thinking skills program as part of the regular language arts period.

The boys and girls in the self-regulation training were impressively successful, as measured by peripheral temperatures, in changing their levels of arousal or relaxation with the assistance of the trainer. On their own, the children continued to be successful in relaxing; however, they failed to master the skill for eliciting the arousal response at will. Although students had difficulty changing their arousal levels, they did improve, with time, both relaxation and arousal skills, indicating that at this age self-regulation may be a skill that requires considerable practice in order to achieve rapid, measurable change.

Throughout the thinking skills program, the experimental group tended to score higher on teacher-made tests than did the control group, but they failed to outperform their

counterparts on a standardized test of higher-order cognitive abilities. The treatment tended to diminish significantly perceived anxiety levels and to improve perceptions of students about themselves. The responses on the scales for behavior and locus of control showed no significant differences between the two groups.

The study illuminates the fact that some middle school children can learn self-regulation skills and can transfer the skills to the regular classroom. More research needs to be performed with arousal training in order to validate its usefulness in the school curriculum.

A STUDY OF THE EFFECTS OF A STRESS MANAGEMENT PROGRAM ON AFFECTIVE AND COGNITIVE MEASURES OF MIDDLE SCHOOL CHILDREN

Middle school children make a number of accommodations that create stress in their lives. In addition to the normal problems that exist in the family, school, and community, there are the adjustments required for changes in the body, pressures exerted by peers, demands by the school for excellence, conflicting attitudes of parents, and other problems with establishing self-identity. The middle school years represent a period of development in which students appear to need assistance with acquiring coping skills for dealing with stress. One of the main coping skills in the management of stress is self-regulation or self-control of physiological aspects of functioning along the relaxation/arousal continuum. The coping technique allows students to adjust the relaxed or aroused state of the body to the activity so that peak performance can occur, whether in the classroom or on the playground. The purpose of this research was to examine the ability of middle school students to achieve self-regulation skills and to investigate the effects of the training program on affective and cognitive behaviors.

To understand the need for self-regulation skills in stress management, it is necessary to clarify the concept of stress. Stress, as defined by Rice (1987), is the strain

or wear and tear on the body due to resisting external forces or pressures. According to Selye (1974), stress has two components, distress and eustress. Distress refers to damaging or unpleasant stress and is much the same as a state of anxiety, fear, worry, or agitation. Eustress is pleasurable with satisfying experiences that tend to heighten awareness, increase mental alertness, and lead often to superior cognitive and behavioral performance. Eustress may supply the arousing motivation to perform at peak levels, thus enabling personal and academic growth. In this research, eustress training and self-regulation training are synonymous.

There appears to be a range on the relaxation/arousal continuum in which persons function best. In 1908, Yerkes and Dodson explained the relationship between arousal and performance, stating that, up to a point, performance will increase as arousal increases. However, performance will be best when arousal is optimum, not maximum. Beyond the optimal level of arousal, performance begins to deteriorate. With exceptionally high levels of tension, performance may be as bad as it is on those occasions when a person is not aroused at all. As an example, one may compare the performance efficiency of a student who is about to fall asleep because of fatigue or boredom with the performance efficiency of another student who is hysterical and note that both are inefficient and nonproductive. At the same time, people

perform at their best when there is at least a moderate degree of pressure. The aim of self-regulation training is to teach students to control the level of stress so that an optimal level of arousal is present.

Optimum stress or arousal levels appear to be related to the type of activity or task. For instance, Yerkes and Dodson (1908) reported that a high level of arousal was needed for the performance of simple tasks, but a moderate level was required for achieving complex tasks. Rubenzer (1984) reported a similar finding when physiological test anxiety level correlated negatively with performance on divergent tasks and intelligence scores but correlated positively with simple number recall tasks. Galassi, Frierson, and Sharer (1981) found that students who increased their levels of arousal for classes and tests had higher grades and test scores than students who maintained low arousal. Mitchell (1984/1985), using the State-Trait Anxiety Inventory for a measure of anxiety, found that students with low anxiety read better the more they were aroused, and highly anxious students read better when they reduced their arousal during reading. Matthews (1987b) found that middle school children in a thinking skills program who were relaxed as a group immediately before testing relaxed beyond the optimum level and, thus, performed less well than some of their counterparts in the control group. At the opposite end of the continuum, the literature is expansive with studies

indicating a reduction in the state of arousal for rest, meditation, and other forms of nonfocused mental activities (Holmes, 1984; Hunter, Russell, Russell, & Zimmermann, 1976; Kappes, 1983; Kelton & Belar, 1983; Matthews, 1986b, 1987b; Schandler & Dana, 1983).

Stress affects the body with a general arousal condition where the muscles tense, blood flows faster, and breathing increases. Because blood flows from the peripheral area of the body toward the trunk when a person is aroused, skin temperature may be used as an indicator of the relaxed and aroused states. Boudewyns (1976) found that finger temperature decreased under assumed stress conditions and increased under assumed relaxed conditions. Rattenbury and Donald (1982) found that finger temperature dropped as tension in the forearm increased. A series of studies showed that students were able to increase or decrease their peripheral temperatures with training, indicating some degree of control over their physiological functioning (Forgey, 1984/1985; Freedman & Ianni, 1983; Gillespie & Peck, 1980; Hershey, 1983; Kelton & Belar, 1983; Schneider, 1976). Because blood flow is directly related to the level of arousal or relaxation (Schneider, 1976) and because a number of inexpensive biofeedback units are available for class instruction, finger temperature was the candidate for measurement of change in this stress management program emphasizing self-regulation skills.

Previous research (Matthews, 1987b) indicated that whole class participation in activities designed for stress management, except for training purposes, was not the appropriate approach for creating a mental state conducive to optimum performance. Rather, relaxation had to be taught as a tool for each individual to employ only if feeling some anxiety prior to a test or other stress-related activity. Indeed, other students probably needed to employ much different techniques to increase alertness or arousal. The focus of this study was to attempt to teach the skill of self-regulation in a whole-class training situation and to make the children responsible for using the procedure throughout the school day as the situation and body state demanded. To insure the continued use of the skill after the initial training period, children practiced on a periodic basis for the duration of the study.

Hypotheses

The research had three phases. Phase I was the self-regulation training that preceded the introduction of the thinking skills program. Only children in the experimental group participated in Phase I. Phase II included periodic practice of self-regulation skills for the experimental group and a thinking skills program, including testing of the skills that were taught, for both the control and experimental groups. In Phase III, all students responded

to several instruments to measure the cognitive and affective effects of the stress management program.

The hypotheses appear in three sets: self-regulation training, self-regulation practice, and cognitive and affective behavior. Cognitive measures were scores on teacher-made tests and a standardized cognitive abilities test. Affective behavior included measures of self-concept, locus of control, problem behavior, and anxiety.

Self-Regulation Training

1. Students will have significantly higher peripheral temperatures following relaxation training than they will have in a rested state.

2. Students will have significantly lower peripheral temperatures following arousal training than they will have in a rested state.

3. Subjects will improve over time in the ability to assess their states of arousal as measured by peripheral temperature.

4. Over time, students will regulate their inner states, as demonstrated by the ability to change their peripheral temperatures in the direction of their assessments.

Self-Regulation Practice

5. Students will improve their self-regulation skills with practice as measured by peripheral temperatures.

Cognitive and Affective Behavior

6. Students who participate in self-regulation training will exhibit increasing scores over time on a series of teacher-made tests in thinking skills relative to a similar group of control students.

7. Students who participate in self-regulation training will score higher on the Thorndike Cognitive Abilities Test than similar students who do not participate in the training.

8. Students who participate in self-regulation training will score higher on the Coopersmith Self-Esteem Inventory than similar students who do not participate in the training.

9. Students who participate in self-regulation training will score lower, indicating internalization, on the Nowicki-Strickland Locus of Control Scale for Children than similar students who do not participate in the training.

10. Students who participate in self-regulation training will rate themselves as having fewer problems on the Jesness Behavior Checklist than similar students who do not participate in the training.

11. Students who participate in self-regulation training will be rated by their teachers on the Ellsworth Child and Adolescent Adjustment Profile as having fewer problem behaviors than similar students who do not participate in the training.

12. Students who participate in self-regulation training will score lower, indicating less anxiety, on the Speilberger State-Trait Anxiety Inventory for Children than similar students who do not participate in the training.

LITERATURE REVIEW

The effects of self-regulation training on academic achievement, intelligence, self-concept, locus of control, behavior, and anxiety appear nonconclusive. Although the review of the literature provided numerous examples of the beneficial effects of relaxation techniques for children, studies reporting conflicting evidence existed.

In attempts to improve the performance of students in academically related areas, researchers employed numerous self-regulation techniques. Some of such techniques impacted positively on reading comprehension (Zenker & Frey, 1985); oral reading rates (Kirk, 1981); writing skills (Gaylean, 1981); paired-associate recall and single-item recognition (Cramer, 1981); digit recall (Conger, 1985/1986); keyboarding (Matthews, 1987c); Spanish skills (Gaylean, 1982); concentration (Disorbio, 1983/1984); overall grade level performance (Lubar, 1985); figure-ground discrimination and intersensory-integration (Hunter, Russell, Russell, & Zimmermann, 1976); and eye-hand coordination, auditory memory, and handwriting legibility (Russell & Carter, 1978). Russell & Carter (1978) found that EMG biofeedback training significantly improved scores

of learning-disabled elementary children on the reading and spelling subtests of a standardized achievement test, but not on the arithmetic subtest. Using progressive relaxation, Spillios and Janzen (1983) produced increases in performance of middle school learning-disabled males on reading recognition, reading comprehension, and mathematics, but increases were not significant. Data analyses in two self-regulation studies with middle school children reflected no significant differences between experimental and control students on performance on weekly achievement tests measuring critical thinking skills (Matthews, 1987a) and speaking and reading ability in French (Matthews, 1982). In other research, Matthews (1982, 1985b) failed to find that relaxation training increased performance of middle school children on standardized achievement tests.

Although it is known that a strong positive relationship exists between achievement and intelligence, some researchers concentrated their efforts on the study of relaxation training and intelligence. Anxiety management training was effective in improving test performance of sixth and seventh graders on measures on intelligence (Wilson, 1980/1981; Wilson & Rotter, 1986). Using biofeedback (EMG) assisted relaxation training, Rubenzer (1984) significantly increased scores on measures of divergent tasks and intelligence for fifth and sixth grade gifted students, and Russell and Carter (1978) increased intelligence scores of learning-disabled elementary

school students. Matthews (1987a), using guided imagery training with middle school children, found that experimental students significantly outperformed control students on three subtests (verbal analogies, figure classification, and figure analysis) of the Cognitive Abilities Test, but not on the total battery.

The literature showed a relationship between relaxation training and self-concept. Although the majority of the research supported an increase in the phenomenon, other studies showed no significant difference between groups with the treatment and those without the treatment. Using relaxation techniques incorporating EMG biofeedback, Krieger (1985/1986) found an improvement in self-concepts of adolescents. Walton (1977) reported, also, that biofeedback training had positive effects on self-concepts among preadolescent and adolescent students. Oldfield (1986), when comparing pretest and posttest scores of fourth through sixth graders, found that students who practiced the relaxation response significantly improved their self-concepts when compared to students in the control group. However, another study (Zaichkowsky, Zaichkowsky, & Yeager, 1986) using biofeedback assisted relaxation training resulted in the failure of elementary school children to improve self-concepts. Anxiety management training proved to be an effective method of increasing self-esteem of students in the fifth through seventh grades (Wilson, 1980/1981; Wilson & Rotter, 1986). However, Kubiak

(1987/1988) reported no significant changes in self-concept of adolescents receiving stress-inoculation training in a short five-week program. Matthews (1985a) reported that females, but not males, responded to relaxation training with improved self-concepts when research was conducted with middle school students under teacher supervision.

Empirical evidence regarding the positive effect of self-regulation training on locus of control in children seems limited. Only one study (Walton, 1977) provided substantiation for the positive relationship between self-regulation training and locus of control. Walton found that biofeedback training produced a significant increase in internalization for preadolescent and adolescent students. However, other studies using biofeedback with hyperactive boys between the ages of 10 and 12 (Gerler & Omizo, 1981; Omizo & Michael, 1982) yielded no effect of this treatment on the internality or externality of students. In research with adolescents, Kubiak (1987/1988) noted that students receiving stress inoculation training had lower scores (an indication of internality) on a measure of locus of control than did the control group; however, the difference between the two groups was not significant. Kratter and Hogan (1982) found no changes in locus of control for hyperactive children who practiced either meditation or progressive relaxation.

Some authorities believe that training in self-control affects behavior in the classroom. For instance, several

researchers found that the procedure improved the alertness and attention spans of children (Dunn & Howell, 1982; Kirk, 1981; Rivera & Omizo, 1980), qualities that students need to achieve. Margolis (1987) proposed that relaxation enables students to remain calm and self-assured, thus making them capable of controlling their behavior in potentially stressful situations. Behaviors that improved with various relaxation strategies were disruptive behavior (Gaylean, 1980, 1982; Matthews, 1982, 1985b, 1986a; Nenortas, 1986; Oldfield, 1986; Weimer, 1987); bragging and threatening or verbally humiliating others (Miller, 1982); absenteeism and tardiness (Monaco, 1982/1983; Nenortas, 1986); hyperactive behavior, including impulsivity (Dunn & Howell, 1982; Gerler & Omizo, 1981; Kratter & Hogan, 1982; Krieger, 1985/1986; Omizo & Michael, 1982); on-task attention (Oldfield & Petosa, 1986); and other inappropriate behaviors (Walton, 1979). The relaxation response has a tendency to reduce the level of bodily arousal, the state associated with action. Although the functioning of neurotransmitters in the brain is unclear, it is possible that relaxation causes the release of natural secretions that regulate the emotions, the affective nature of human beings that controls behavior.

Results of the effectiveness of self-regulation training as it related to anxiety varied. According to Deffenbacher and Kemper (1974), systematic desensitization was helpful in reducing academically related anxieties of

junior high school students. Likewise, relaxation training proved effective as a means of lowering test anxiety (a type of state anxiety) among elementary, as well as middle school, children (Kirk, 1981; Smead, 1981; Wilson, 1980/1981; Wilson & Rotter, 1986). Laird (1981), when working with high school students, and Smead (1981), when instructing sixth graders, found that students responded to relaxation techniques with significantly lowered rates on physiological measures and, thus, decreased state anxiety. Other researchers (Zaichkowsky, Zaichkowsky, & Yeager, 1986) noted, however, that elementary students receiving biofeedback-assisted relaxation training demonstrated significant control over three physiological measures normally associated with state anxiety, but the children were unable to lower self-reported state anxiety. Conger (1985/1986) stated that fourth graders participating in an anxiety reduction program effectively lowered state anxiety scores and that students with the highest anxiety levels were the most successful in lowering those scores. For Jasnow (1982/1983), relaxation training was effective in reducing trait anxiety and neuroticism for sixth graders. In a study by Hiebert and Eby (1985), high school students significantly decreased both state and trait anxiety following relaxation training. Davis (1986/1988), after administering an instructional program in progressive muscle relaxation to seventh graders, noted that neither state anxiety nor trait anxiety decreased significantly.

Kubiak (1987/1988) reported similar results when using stress inoculation training with adolescents. Ragan and Hiebert (1987) found no overall significant effect for relaxation on state anxiety or trait anxiety for children in kindergarten through third grade; however, they did find a significant decrease in trait anxiety for third graders. In work with fifth grade students, Monaco (1982/1983) noted a reduction, but not a significant one, in general anxiety.

In reviewing the literature, one notices an obvious tendency for most self-regulation training to focus only on the reduction of anxiety. However, if there is an optimum level of stress that is necessary for maximum performance, then, any self-regulation program should include arousal, as well as relaxation, training. The purpose of this study, therefore, was to test the effects of a program in self-regulation training that incorporated both relaxation and arousal training on the performance of middle school students in several cognitive and affective areas.

METHOD

Sample

Students in the sixth and seventh grades at Felton Laboratory School at South Carolina State College were the subjects in the study. The sample consisted of 24 boys and 31 girls, making a total of 55 children. With the exception

of two students, the participants were black. The majority of the families of the children were middle class.

Before school began, the researcher received the list of students who were to attend the school in the fall and randomly assigned the students by strata to two groups. The strata were grade level (6 and 7) and sex (male and female). One group was the trained (experimental) group and the other was the untrained (control) group.

Children who entered school during the year were not part of the study. One girl moved while the study was in operation, and one boy failed to get parental permission to participate. Therefore, the sample size decreased by two, making 53 the actual number of participants.

Procedure

The two-group, treated and untreated, experimental design had three phases that spanned the entire school year. Phase I, consisting of seven weeks of self-regulation training for the experimental group, extended from August 31 to October 16. Phase II, from October 19 to April 7, included 15 periodic practice sessions of self-regulation skills for the experimental group and a thinking skills program for both the treated and untreated groups. The thinking skills program provided a common curriculum for both groups under controlled conditions. Testing occurred in the program after the instruction for each of the nine skills. Phase III, the

testing, started on April 11 and concluded on May 6. Figure 1 synthesizes information related to the design of the study.

Because the self-regulation training appeared to be part of the physical education curriculum and the thinking skills program part of the language arts curriculum, the control group had no reason to suspect that the two treatments were related and, therefore, were blind to the design. The researcher taught the curriculum for self-regulation training in a classroom separate from the school building. However, a specially trained teacher whose duties were to administer the program in thinking skills taught the skills in the regular classroom as part of the perceived normal curriculum.

In Phase I, the experimental students went across the street from their school to the Lewis Learning Laboratory two times per week for self-regulation training. Each session, scheduled during the physical education period, lasted for one hour. In addition to learning about the theory involved with stress, the students practiced changing their peripheral temperatures to three states: rested, aroused, and relaxed. While the experimental students engaged in self-regulation training, the children in the control group participated in their regular physical education activities. After Phase I, the experimental students continued to practice self-regulation skills once a week throughout the year, except when school activities or holidays interfered.

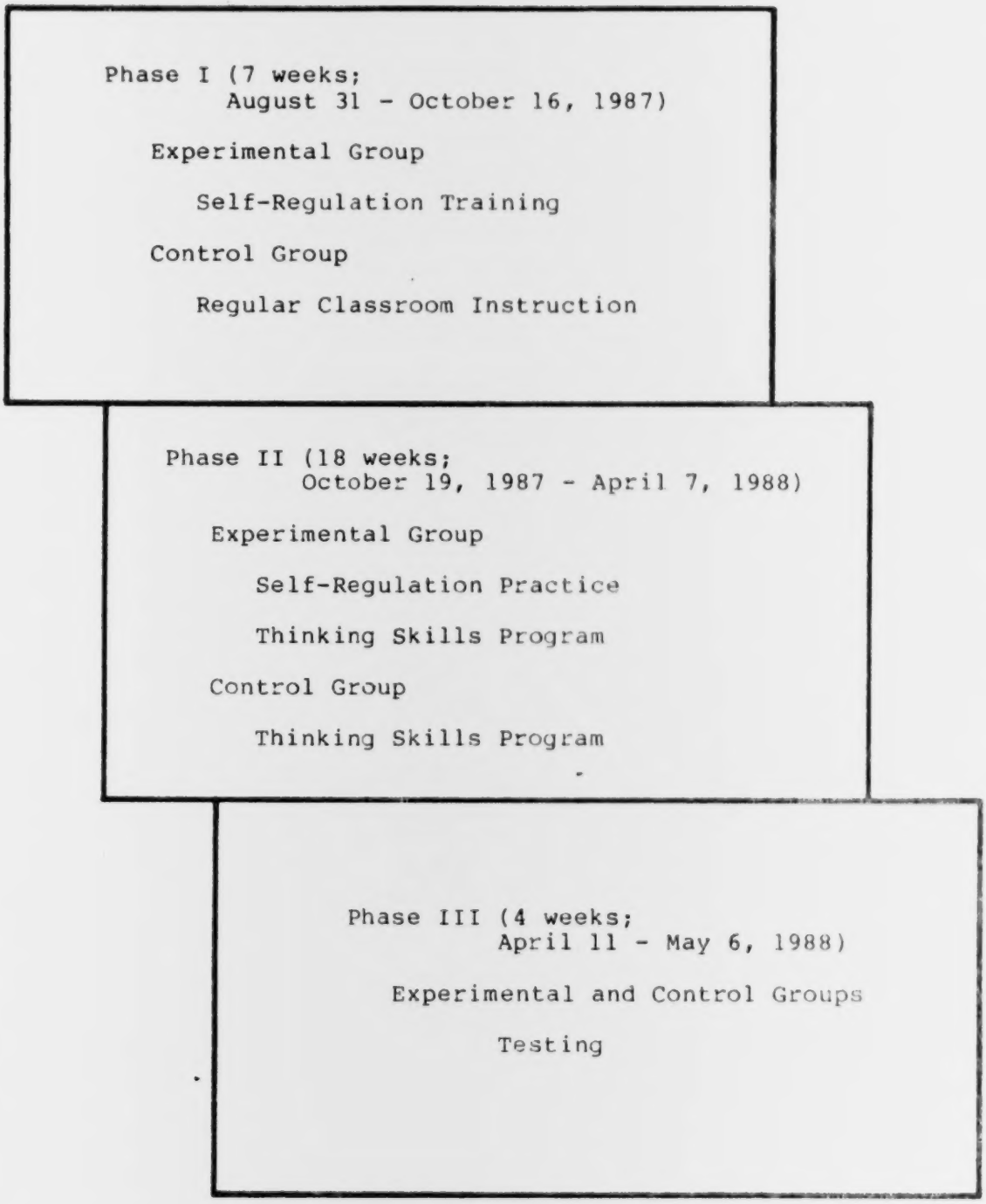

Figure 1. Research Design

In addition to self-regulation practice for the trained group, Phase II included the thinking skills program. Two classes of sixth grade students and two classes of seventh grade students received thinking skills instruction during their language arts class two times per week for a total of 18 weeks. During the first half of each class on the first day of instruction in a skill, students received an introduction to the skill through discussion, as well as through visual aids. In the last half of the hour, students completed the activities assigned for that particular day. The other days of instruction on a skill included the review of the previous work and the assignment of more activities for practice. For those students who completed the assigned activities before the end of class, enrichment activities provided a further challenge. Instruction on each thinking skill lasted three days. On the fourth day, the students took a teacher-made test on the skill taught in the two-week instructional period. Table 1 shows the schedule followed during the cycle of instruction. Christmas holidays interrupted Lesson 4 on qualitative concepts.

When the thinking skills program was completed, the thinking skills teacher administered a number of relevant tests to the two groups. The administration of tests at the end of the program made a logical conclusion to the instruction and apparently disassociated the testing from the self-regulation training.

Table 1

Schedule for Teaching Thinking Skills

Lesson	Dates of Class Meetings	
	6th Graders	7th Graders
Verbal Classification	October 19, 20, 26, 27	October 21, 22, 28, 29
Sentence Completion	November 2, 3, 9, 10	November 4, 5, 11, 12
Verbal Analogies	November 16, 17, 30 December 1	November 18, 19 December 2, 3
Quantitative Concepts	December 7, 8 January 4, 5	December 9, 10 January 13, 14
Number Series	January 18, 19, 25, 26	January 20, 21, 27, 28
Equation Building	February 1, 2, 8, 9	February 3, 4, 10, 11
Figure Classification	February 15, 16, 22, 23	February 17, 18, 24, 25
Figure Analogies	February 29 March 1, 7, 8	March 2, 3, 9, 25
Figure Analysis	March 28, 29 April 4, 5	March 30, 31 April 6, 7

Instruction

Self-Regulation Training

The curriculum for the self-regulation training rested upon six principles. These principles were:

1. Children are capable of learning to change their mental states through self-regulation. Using biofeedback instrumentation to measure bodily changes, children have demonstrated that they have the ability to affect bodily states. This ability, when applied to learning and other functioning, has the potential to improve achievement and attitudes about oneself and the environment.

2. On the relaxation/arousal continuum, one point is best for learning. Because students come to learning sessions in various levels of stimulation, training for arousal will be counterproductive on already aroused learners, and relaxation training will be counterproductive on already relaxed learners.

3. Arousal requires an appropriate object. Whereas relaxation has no focus, arousal always has at least one focus, sometimes several. Thus, when one achieves a state of arousal, the object of the arousal must be identified as appropriate or inappropriate. An object of arousal that is inappropriate can hamper learning; therefore, the person must use methods to transfer arousal to an appropriate object, which usually requires relaxing the original arousal away and rearousing to an appropriate object.

4. Finding the best point between relaxation and arousal takes time and practice. Students can learn to relax and to arouse themselves, but they learn slowly and require substantial practice with the support of biofeedback data.

5. Moving to the ideal spot on the relaxation/arousal continuum requires knowledge of current location. Before a student can invoke relaxation or arousal, he or she requires access to data on the current state of arousal. Thus, an overly aroused student may need to relax, or a student who is too relaxed may need to become aroused; but first the student must accurately identify his or her state as being either overly aroused or excessively relaxed.

6. Some students may achieve ideal eustress more easily than others. Students may use temperature measures at the fingertips to denote the levels of arousal, but training some students may require more sophisticated biofeedback data.

Students received instruction in the use of a model of self-regulation that resembled a central cavern with many tunnels leading away from it. The cavern represented relaxation, a nonfocused mental condition in which all destination tunnels were equally available. All tunnels represented increasing arousal, with each characterized by its own object(s). Thus, for example, one might have led to combat, another to food, or another to learning. Almost all useful work was done in one tunnel or another, but one

could not simply choose a destination randomly. Because relaxation was the direction out of every tunnel, arousal or an inappropriate topic required motion in a direction toward relaxation until the arousal was reduced enough to select another object. Thus, one could speak of generic, or generalizable, forms of relaxation, but one could not speak usefully of arousal without its specific object(s).

The task of the learner who expected to manipulate his or her arousal was straightforward. First, the present location of the student had to be identified. Next, if the location of the student was inappropriate, he or she used skills of relaxing or becoming aroused to move to a more appropriate location. The instructor made no attempt to teach arousal training in any other dimensions than (1) preparing to learn and (2) preparing to take tests.

Specific objectives of the self-regulation training appear in Appendix A. The training included instruction in two aspects of stress management: (1) basic knowledge of the general adaptation syndrome and (2) self-regulation skills. Knowledge of the body and its reaction was an integral part of the training that was required to move from one mental state to another. Taught relaxation procedures were imagery, quieting response, autogenics, and progressive relaxation. Initially, the trainer administered these techniques live but used audiocassettes later in the program during the practice portion of self-regulation training. Because few

materials exist for arousal training, the trainer developed exercises that required students to answer simple questions quickly, spell easy words rapidly, repeat suggestive rhymes, and imagine stimulating scenes. Imagery was the method that was emphasized as transferring to the classroom for practical use, whether moving in the direction of arousal or relaxation. A list of materials used in the training appears in Appendix B.

To collect biofeedback data on their own levels of arousal, the students used fingertip temperature measurements. Temperatures in the peripheral areas of the body increased as relaxation occurred and decreased with increasing arousal. First, students experimented with measuring their fingertip temperatures and observing the temperature variations consonant with various states of relaxation or arousal. Then, they tried to predict their fingertip temperatures by analyzing their own states of arousal. Next, the students observed their actual fingertip temperatures to provide data to test and adjust their guesses. Finally, they had two minutes to alter their temperatures in the direction of their guesses. During this time, the children used the digital temperature display on electric thermometers as biofeedback.

In every hour during the training in Phase I, the children guessed one temperature measure in each of three states. The three conditions were:

1. Rested state, at the beginning of the class;
2. Relaxed state, at the end of an exercise to evoke relaxation; and
3. Aroused state, at the end of an exercise to produce arousal.

Children demonstrated self-regulation by attempting to change their temperatures toward the direction of their guesses. This activity placed each student in one of four conditions: (1) following relaxation training, the student assessed his or her temperature as higher than it actually was, and now needed to relax more; (2) following relaxation training, the student assessed lower than actual temperature, and needed to become more aroused; (3) following arousal training, the student assessed temperature higher than actual and needed to relax; or (4) following arousal training, the student assessed temperature lower than actual and needed to become further aroused. Each of these conditions represented a distinctly different challenge. Students had either to continue relaxing because they did not achieve their goal during relaxation training or to halt the relaxation because they had exceeded the estimate. Likewise, following arousal training, they had either to continue arousal or to change to relaxation. Within each of these four conditions, the researcher considered students well-trained if their temperatures moved in the intended direction.

Concomitant with the recording of each set of measures, the researcher recorded the ambient temperature in the room. Although students recorded their guesses on the data sheets, research assistants recorded the actual temperature readings from the finger temperature indicators. Appendix C shows an example of data sheets for recording temperatures in the rested, relaxed, or aroused state. To vary the direction of movement from the rested state, the researcher developed by randomization a variable schedule for practice of arousal and relaxation.

Readings collected from daily observations and tabulated using the computer allowed the researcher to monitor the effect of the training and to identify students whose training seemed ineffective. Such students received extra help in additional tutorial time.

After the initial seven weeks of instruction, students continued the self-regulation training one day per week in order to maintain the skills learned in the beginning sessions. The instruction for practice was essentially the same as that of the training period, with the exception of making only two sets of measures--one for arousal and one for relaxation. In addition to continuing to emphasize movement from one state to another as measured by peripheral temperatures, the training focused on transfer skills so that the students would see the usefulness of the training in the regular classroom

situation. Instruction in transfer skills included assessing the task for the appropriate mental state in order to perform at maximum for that activity. For example, children learned that problem solving and speaking before a group may require a mental state of medium arousal, but listening to the television or a record may necessitate a semirelaxed state.

During the practice sessions, every student experienced each of the four conditions that were described previously in this section of the report in the discussion of the initial training. Again, the researcher considered the student to be well-trained if his or her temperature moved in the intended direction a majority of the time. Overall, a student was well-trained if he or she was successful in three or four of the four training conditions. These criteria ensured that a "successful" student was one who changed finger temperature at will a majority of the time and who demonstrated this skill in both directions, toward relaxation and arousal.

Thinking Skills Instruction

The thinking skills teacher organized classroom instruction chronologically into three categories: verbal skills, mathematical skills, and figurative reasoning skills. Verbal skills included word classification, sentence completion, and word-concept analogies. The second category comprised quantitative concepts, number series, and equation building.

In the third group (drawings and images) were abstract figurative classification, figurative analogies, and figurative analysis.

In the task of verbal classification, students sorted words and objects into groups according to their common qualities in language. The task in sentence completion involved identifying the thought or idea expressed or denoted in a sentence with one or more words missing by selecting a leading word or phrase that completed the intention of the sentence. Verbal analogies, of course, involved ability of students to discern the similar relationship between two pairs of objects or abstractions.

In the category of quantitative concepts, the students measured the aspects by which a perception was in fact measurable in terms of greater, less, equal, or increasing or decreasing magnitude. In the number series category, the students had to determine numbers succeeding each other by the logical process of addition, subtraction, multiplication, division, or any combination thereof. To deal with equation building, the students needed to indicate the logical order of the special relationships involved in a contained sequence of mathematical operations, such as multiplication followed by subtraction. This category measured capacities for abstract reasoning.

Figure classification involved images or pictures of some sort. The students had to distinguish the systematic

arrangement of figures according to established criteria, such as hierarchies of size or geometrical arrangement. Figure analogies concerned perceiving kinds of images that bore resemblance to one another either in a few general characteristics or many and implied agreement with other figures having similar characteristics. The last skill, figure analysis, dealt with the identification of subtle differences in shapes and sequences of figures, but with differentiating means of producing these changes.

Before instruction began, the teacher made lesson plans and compiled student activity booklets from published material. The design of the lessons required students to complete several assigned activities during each class meeting and then to move on to enrichment activities intended to supplement the required activities. Students applied the experience of the required activities to meet the challenge of the enrichment activities. Students who worked more slowly than others completed the enrichment activities at home.

Materials for instruction came from a variety of sources. For the verbal and nonverbal activities, the instructor used mainly the thinking skills activities prepared by Midwest Publications and Innovative Sciences. The mathematics textbooks by Laidlaw Brothers and Charles E. Merrill Publishing Company provided the majority of materials for teaching the quantitative portion of the program. Appendix D is a complete listing of references used with all of the skills.

Also in the appendixes are examples of a lesson plan (see Appendix E) and a study activity booklet (see Appendix F) that were used with the children.

Instrumentation

Finger Temperature Indicator

The finger temperature indicator registered measures of ambient temperature and peripheral temperatures of the students. The indicator, manufactured by Human Systems Measurement, was the Enviro-Temp. The Enviro-Temp is a small unit with a probe which can be attached with porous hypoallergenic tape to the middle finger on the dominant hand. The liquid crystal display on the instrument ranges from 0 degrees to 199 degrees Fahrenheit. The measurements are accurate within $\pm$ 2 degrees Fahrenheit. Because the calibration varies slightly on the instruments, the child kept the same temperature indicator throughout the training and practice sessions, thus enabling the student to be more accurate in his or her assessments.

Teacher-Made Thinking Skills Tests

Prior to the initiation of the instructional program, the teacher employed to teach the thinking skills program developed tests that corresponded to the nine thinking skills. The instructor constructed the tests by extracting items directly from the daily activities, as well as by formulating new items unfamiliar to the students but similar to the ones the students practiced in class. Although these

tests did not undergo field testing, items for each skill received scrutiny by a panel of two curriculum specialists who had expertise in the development of thinking skills items, thus assuring the researcher of content validity of the instruments. Appendix G contains an example of the teacher-made tests.

The instructor calculated the scores of the students by counting the number of correct responses. Because the total number of items varied from test to test, the instructor determined a score by figuring the percentage of correct items.

Cognitive Abilities Test

The Cognitive Abilities Test by R. L. Thorndike and Elizabeth Hagan is a standardized measure of mental aptitude. The researcher used levels C-F of the multilevel edition of the test in this study. The multilevel edition contains eight overlapping levels for Grades 3 through 12: A (3), B (4), C (5), D (6), E (7), F (8-9), G (10-11), and H (12) (Mitchell, 1985). The test consists of three batteries: verbal, quantitative, and nonverbal. The verbal battery is made up of three subtests: verbal classification, sentence completion, and verbal analogies. The quantitative battery consists of quantitative relations, number series, and equation building subtests. The nonverbal battery, which is entirely pictorial and diagrammatical, has three parts: figure classification, figure analogies, and figure analysis.

Coopersmith Self-Esteem Inventory

The School Form of the Coopersmith Self-Esteem Inventory by Stanley Coopersmith is a standardized measure of self-concept that is applicable to students aged 8 through 15. The inventory is a self-report scale consisting of 58 short statements with two possible answers: "like me" or "unlike me."

The instrument yields six scores: a separate score for each of the four subscales (General Self, Social Self-Peers, Home-Parents, and School-Academic); a total score on the self-esteem items (50 items); and a score on the Lie Scale, a measure of defensiveness or test wiseness reflected in responses to eight questions on the inventory. On the total score on the self-esteem items, high scores are indicative of high self-esteem; however, high scores on the Lie Scale, which is always scored separately from self-esteem sections, have the exact opposite interpretation in that such scores indicate defensiveness and a lack of test wiseness.

Nowicki-Strickland Locus of Control Scale for Children

This scale, developed by S. Nowicki and B. R. Strickland, measures the generalized expectancy for control, either internal or external, in children. It is a standardized paper-and-pencil self-report measure containing 40 questions to which the child responds by placing a check mark in either the "Yes" or "No" column which precedes each question. The items relate to a variety of areas, such as affiliation,

achievement, and dependency. The scale has a wide range of applicability (Grade 3 through Grade 12). A high score reflects external orientation.

Jesness Behavior Checklist

The Jesness Behavior Checklist, a standardized self-report instrument by Carl F. Jesness, provides a systematic way of recording data about social behavior. This instrument may be used with persons aged 10 or above and in a variety of settings. The checklist consists of 80 items that measure 14 bipolar behavioral factors: (1) unobtrusiveness versus obtrusiveness, (2) friendliness versus hostility, (3) responsibility versus irresponsibility, (4) considerateness versus inconsiderateness, (5) independence versus dependence, (6) rapport versus alienation, (7) enthusiasm versus depression, (8) sociability versus poor peer relations, (9) conformity versus nonconformity, (10) calmness versus anxiousness, (11) effective communication versus inarticulateness, (12) insight versus unawareness and indecisiveness, (13) social control versus attention-seeking, and (14) anger control versus hypersensitivity. Scoring of answers is on a five-point scale: Almost Never, Not Often, Sometimes, Fairly Often, or Very Often. Low scores indicate the presence of behavioral problems.

Child and Adolescent Adjustment Profile

R. B. Ellsworth designed the Child and Adolescent Adjustment Profile for use by parents, teachers, counselors, therapists, and probation officers to determine how often

during a preceding month a child exhibited each of 20 behaviors. The document yields five scores: peer relations, dependency, hostility, productivity, and withdrawal. The sum of the ratings for the four behaviors associated with each factor provides scores for the five adjustment dimensions. Transference of summed scores to a profile sheet permits easy detection of high and low areas of adjustment. The same profile sheet is available for use in recording scores of a second rating in measuring change in adjustment over time. High scores on peer relations and productivity represent exemplary behavior; however, high scores on dependency, hostility, and withdrawal reflect problem behavior.

State-Trait Anxiety Inventory for Children

C. D. Spielberger, in collaboration with C. D. Edwards, R. E. Lushene, J. Montouri, and D. Platzek, designed the State-Trait Anxiety Inventory for Children (also known as the How I Feel Questionnaire) specifically for use with students in the 9-12 year age bracket. The standardized inventory contains two self-report scales: state anxiety and trait anxiety. The 20 state anxiety questions measure transitory anxiety, that is, how the student feels at a particular moment in time. Students select the best of three possible answer choices (example, "I feel ... very calm, calm, not calm."). The 20 trait anxiety questions measure relatively stable individual differences in anxiety proneness, that is, how the students feel generally. Students

respond by choosing the answer choice that best describes them (hardly ever, sometimes, or often). High scores on both scales are reflective of detrimental anxiety.

Data Analysis

Self-Regulation Training and Practice

The investigator analyzed all of the data using the Statistical Analysis Systems (SAS) computer software. The design of the study called for peripheral temperatures to be measured and analyzed in degrees Fahrenheit, as well as change in temperature. However, the researcher transformed the scale so that positive numbers represented the number of degrees moved in the desired direction and negative numbers represented the number of degrees moved in the wrong direction.

Two-way and three-way analyses of variance were the tests for further exploration of peripheral temperature changes. These tests allowed the examination of such main effects as the practice effect over time, the initial state, and the direction of movement.

Cognitive and Affective Measures

The researcher compared the mean scores for the experimental and control groups on the teacher-made thinking skills tests, the Cognitive Abilities Test, the Coopersmith Self-Esteem Inventory, the Nowicki-Strickland Locus of Control Scale for Children, the Jesness Behavior Checklist, the Child and Adolescent Adjustment Profile, and the State-Trait

Anxiety Inventory for Children by using t tests for independent samples. Rejection of the null hypothesis of no difference between the means resulted if the value of t had a probability of occurring by chance of less than .05.

RESULTS

Self-Regulation Training

Hypotheses 1 and 2

The self-regulation training consisted of two sessions per week for seven weeks. The training produced only twelve peripheral temperature measures per student for each of three states (relaxed, rested, aroused) because the first week was used for orientation. Table 2 presents the mean peripheral temperature for each of the three states. As anticipated, the lowest mean temperature occurred following arousal training; the highest mean temperature occurred following relaxation training.

A research assistant measured the temperature in the room every time that finger temperatures were observed. These measurements were necessary because ambient temperature has an obvious effect on skin temperature. Although there is a previously observed relationship between ambient temperature and skin temperature, the exact effect of the air temperature on peripheral temperature remains unknown.

According to observations, the room temperature varied seven degrees Fahrenheit (from 70.4° to 77.4°) during the

Table 2

Mean Peripheral Temperature in Relaxed, Rested, and Aroused States

State	Mean	St. Dev.
Relaxed	89.76	4.16
Rested	88.02	5.25
Aroused	86.32	4.69

twelve training periods. However, the measurement of 70.4° Fahrenheit appeared to be an aberration; the next lowest recording was 73.4° Fahrenheit. Thus, among eleven measures, the air temperature varied by only four degrees. While this variation of ambient temperature may have had some effect on peripheral temperature, this small variation was inconsistent in its relationship with finger temperature.

The correlation between peripheral temperatures and ambient temperature was .25. Examination of the bivariate plot, however, revealed that this relationship was difficult to grasp and might not have been linear. This observation raised the speculation that ambient temperature might have had differential effects on individuals. The correlation between ambient temperature and the ability of individuals to change their peripheral temperatures was -.11, accounting for only 1 percent of the total variance.

Because there was no clear indication in this study of a method, or even the need, to adjust peripheral temperatures for the ambient temperature, no adjustment for ambient temperature was necessary. However, this finding does not mean that no adjustment is ever justified. To determine the nature of such an adjustment would require a study encompassing a greater range of temperatures than those indicated in this research. It is likely that any such adjustment would be a rather gross one, justified only when temperatures vary abnormally.

The first two hypotheses stated that, in comparison to the mean peripheral temperature for the rested state, the mean finger temperature for the relaxed state and for the aroused state would be significantly different; that is, peripheral temperature would be significantly higher following relaxation training than in the resting state and significantly lower following arousal training than in the resting state. Also, there was the implied hypothesis that this change in finger temperature was a fairly uniform phenomenon across individuals despite individual differences in natural, resting temperatures.

To examine these hypotheses, the researcher conducted 2 two-way analyses of variance with state as one main effect, individuals as the second main effect, and the interaction of state and individual. The first analysis examined the resting state versus the relaxation state; the second analysis examined the resting state versus the arousal state. Although the standard deviation in peripheral temperatures within states appeared high relative to the differences across states (see Table 2), these variations were largely due to individual differences. Table 3 shows the results of the analysis of variance comparing the peripheral temperatures of the relaxation state to those of the rested state; however, the overall model results are not presented because of the inclusion of the large individual difference effect that is not of research interest in the study. The results of the

Table 3

Results of the Analysis of Variance Comparing Peripheral Temperatures Following Relaxation Training with Those in the Rested State

Source	df	SS	F	p
State	1	468.81	29.68	.0001*
Individual	26	4774.96	11.63	.0001*
Interaction	26	168.22	0.41	.9962

*$p < .05$.

main effects and the interaction indicated that there was a significant difference between the two states. Peripheral temperatures were significantly higher following relaxation training than in the rested state. Further, the lack of a significant interaction indicated that this temperature change was a consistent phenomemon across individuals even though their initial resting temperatures differed significantly.

Similar results appeared when comparing peripheral temperatures following arousal training with those in the rested state (see Table 4). The significant state effect indicated that peripheral temperatures were significantly lower following arousal training than they were in the rested state. There was no significant interaction between the state effect and individuals, indicating that the effect was consistent for all subjects.

Hypothesis 3

The subjects guessed their peripheral temperatures prior to each measurement. Given their growing understanding of why temperatures change and their continuing practice in self-awareness, the researcher hypothesized that the subjects would be able more nearly accurately to assess their inner states as time passed; thus, the differences between their guessed temperatures and their actual temperatures would decrease.

Figure 2 plots the absolute values of the differences between the average guesses of the subjects and their average

Table 4

Results of the Analysis of Variance Comparing Peripheral Temperatures Following Arousal Training with Those in the Rested State

Source	df	SS	F	p
State	1	447.19	24.84	.0001*
Individual	26	4910.20	10.49	.0001*
Interaction	26	240.62	0.51	.9791

*$p < .05$.

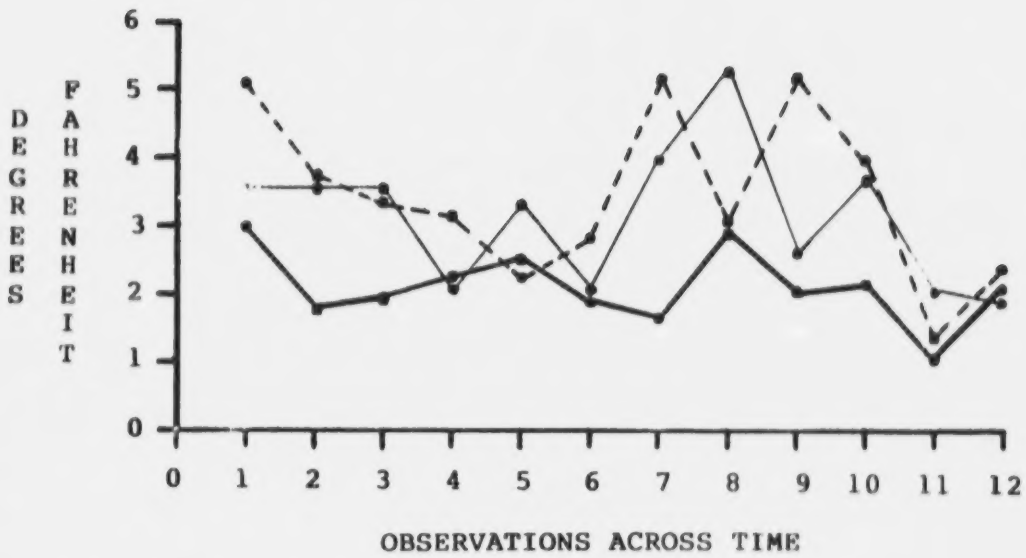

Figure 2. Absolute Values of Difference Between Assessed and Actual Temperatures Across Time

Key: Relaxed ——————

Rested - - - - -

Aroused ——————

actual temperatures across time. There appeared to be a downward trend (i.e., the assessment appeared to be getting more nearly accurate); however, there were wide variations. There was a downward trend for the first six sessions, as well as the last three.

It was apparent from Figure 2 that the ability accurately to assess peripheral temperature was related, also, to the state in which the subjects were: relaxed, rested, or aroused. Assessment was more nearly accurate when the state of arousal followed the relaxed state and was least nearly perceptibly accurate in the rested state.

An analysis of variance tested whether the improvement in assessing temperature over time was significant. The state (relaxed, rested, or aroused) was a second factor because of the obvious influence of state on temperature. As the results in Table 5 reveal, the time of the session (early or late in the series of measurements) related significantly to the ability of the students to guess their temperatures. There was significant improvement in later sessions although this result was complicated somewhat by the interaction of time and state.

Hypothesis 4

After subjects tried to assess their inner states, guessed their peripheral temperatures, and measured their temperatures, the students attempted to change their peripheral temperatures in the direction of their guesses. In this

Table 5

Results of the Analysis of Variance on the Ability to Guess Peripheral Temperature with Repeated Practice

Source	df	SS	F	p
Time	11	447.36	4.52	.0001*
State	2	311.38	17.31	.0001*
Interaction	22	370.14	1.87	.0090*

*$p < .05$.

way, the students demonstrated the ability to use the skills that they had learned in group exercises to control their inner states simply through concentrating either on focusing or relaxing.

First, the researcher analyzed the changes separately for students who guessed high as opposed to those who guessed low. Subjects whose assessments were too high received instructions to relax in order to bring their peripheral temperatures up to their assessments. Students whose assessments were too low received instructions to concentrate on quick questions and other "arousing" thoughts in order to lower their peripheral temperatures. The positive scores depicted in Figures 3, 4, and 5 represent movement in the correct direction, whether up or down; the negative scores represent movement in the opposite direction. The graphs show clearly that students who guessed too high (denoted as "relaxing" because that was the goal) were effective in raising their peripheral temperatures (points above zero represent successful attainment or movement toward the goal; points below zero indicate inability to attain the goal). These results indicated that the subjects learned the ability to relax independently of the group exercises; however, those who guessed low (and were trying to become more alert) were unsuccessful. In fact, the peripheral temperatures of students, on average, tended to

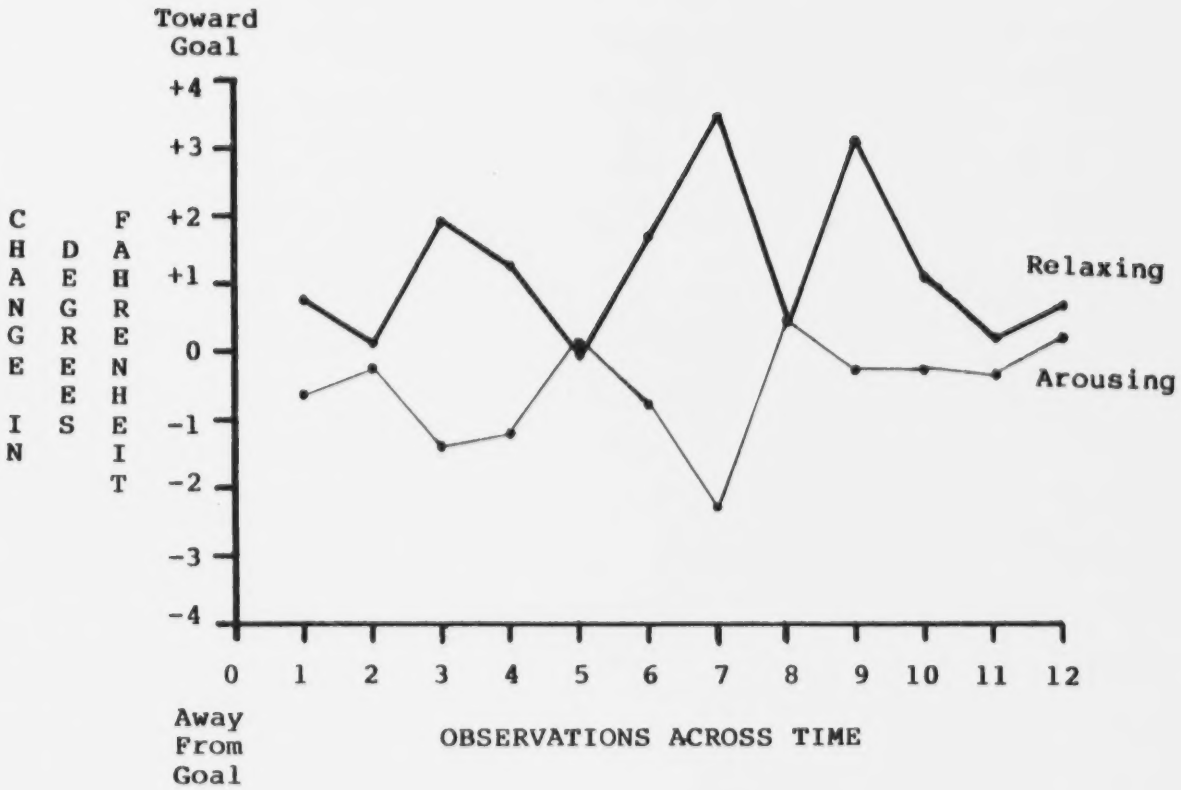

Figure 3. Attempts at Changing Temperatures Toward Guesses Following Rest.

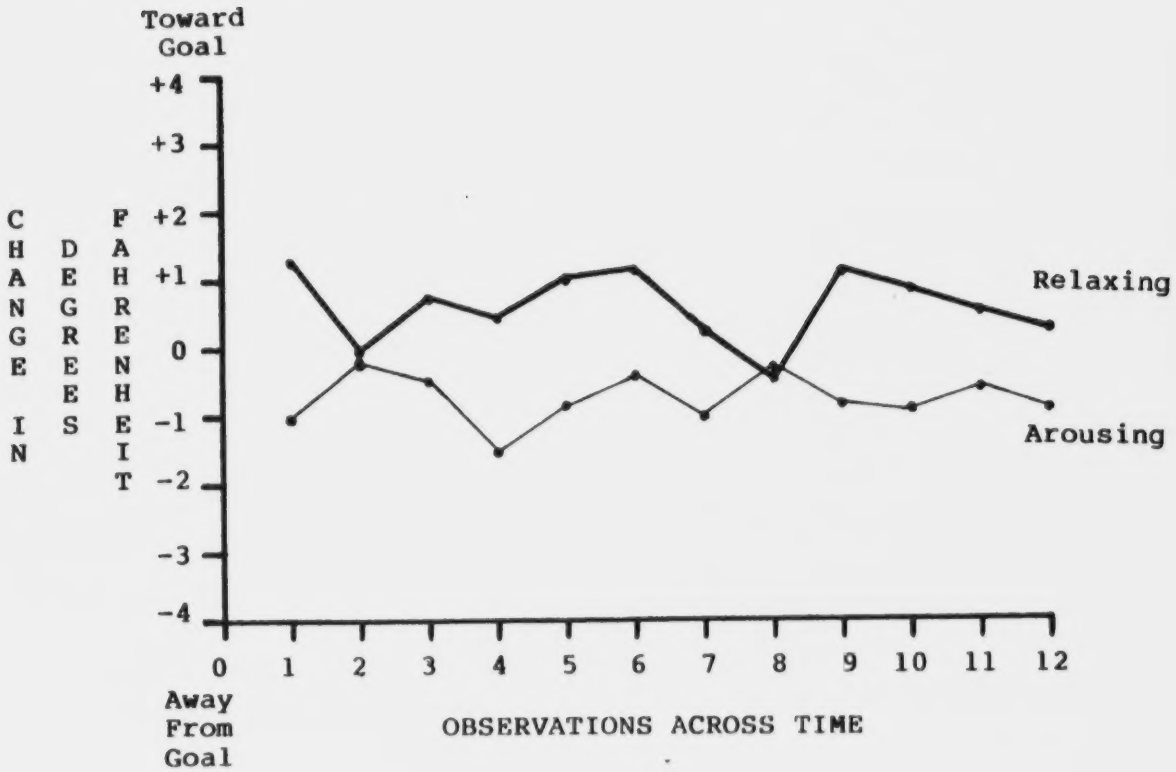

Figure 4. Attempts at Changing Temperatures Toward Guesses Following Relaxation.

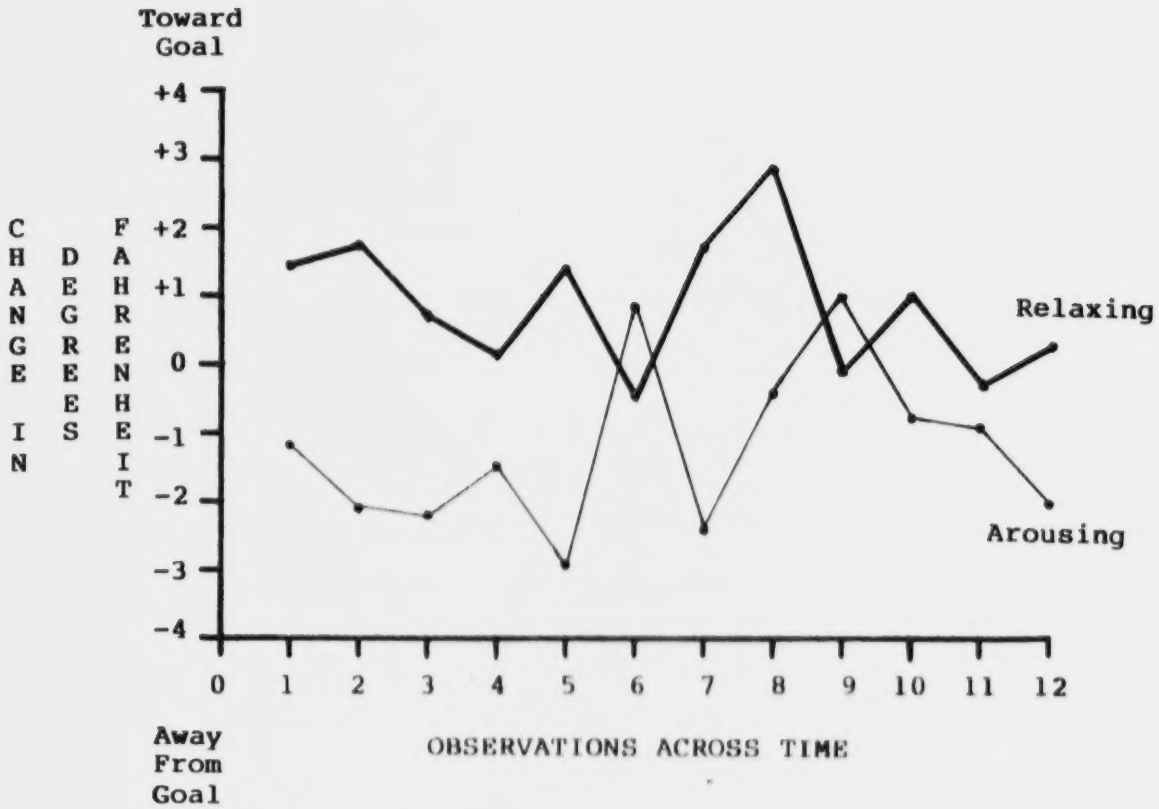

Figure 5. Attempts at Changing Temperatures Toward Guesses Following Arousal.

rise slightly rather than to decline. Repetition of this pattern is evident across all three graphs: (1) the first graph depicts the attempts to change temperature following the resting period, (2) the second graph is a representation of temperature changes following the relaxation exercise, and (3) the third graph is a model of temperature changes following the arousal exercises. In conclusion, it appeared that students were reasonably successful in self-relaxation but did not learn self-arousal sufficiently.

Also, the graphs indicated that the subjects did not improve their ability to change their peripheral temperatures with practice (the later changes did not appear to be remarkably higher or more positive than the earlier changes). The researcher tested these effects via a three-way analysis of variance with the main effects being direction (whether students were trying to increase or decrease temperature), observation, and initial state. The results are in Table 6. All three main effects were statistically significant; however, the overall interaction was significant, also.

The directions of the three main effects appear in Table 7 through Table 9. Table 7 gives the means and standard deviations of the change in temperature for the two conditions of trying (1) to relax (raise temperature) and (2) to become alert (lower temperature). Each mean indicates the average movement in the intended direction. Table 7 reveals that when trying to raise finger temperatures,

Table 6

Results of Analyses of Variance for Effects of Direction, Observation, and Initial State on Peripheral Temperature

Source	df	SS	F	p
Direction (D)	1	625.86	124.09	.0001*
Observation (O)	11	117.03	2.11	.0176*
State (S)	2	46.04	4.56	.0107*
D * O Interaction	11	93.14	1.68	.0735
D * S Interaction	2	21.15	2.10	.1235
O * S Interaction	22	162.12	1.46	.0789
D * O * S Interaction	22	303.14	2.73	.0001*

*$p < .05$.

Table 7

Overall Mean Changes in Peripheral Temperature for Intended Direction of Movement

Condition	Mean	St. Dev.
Relaxing	0.97	2.62
Arousing	-0.74	1.80

the students were successful; however, when trying to lower temperatures, they were unsuccessful, with temperatures moving generally in the wrong direction.

Table 8 shows the means and standard deviations of the second main effect, the general state, whether the measures followed rest, relaxation training, or arousal training. While students were moderately successful overall in changing peripheral temperatures in the intended direction in all three states, it appeared that they were generally most successful in changing their temperatures in the intended direction when they were in the rested state. It is likely that the preceding training period, whether in relaxation or arousal, interfered with the internal attempt to change course.

The means and standard deviations of each of the twelve observations, the third main effect, are in Table 9. No clear pattern was evident. There was certainly variance, but in no consistent manner.

There were two reservations concerning the means of all three main effects. First, there was a significant interaction that altered any serious conclusions. Second, even considering the main effects, the standard deviations were large enough that, despite the statistical significances, these results were not consistent enough to warrant decision-making. At best, the results were directional.

Table 8

Overall Mean Changes in Peripheral Temperature for Initial State (Rested, Relaxed, Aroused)

State	Mean	St. Dev.
Rested	0.49	2.68
Relaxed	0.12	1.79
Aroused	0.16	2.86

Table 9

Overall Mean Changes in Peripheral Temperature Across Observations

Observation	Mean	St. Dev.
1	0.33	2.82
2	-0.50	1.85
3	0.37	2.18
4	-0.15	1.81
5	0.14	2.72
6	0.49	1.85
7	0.88	3.60
8	0.63	3.20
9	0.70	2.85
10	0.48	2.05
11	-0.25	1.69
12	-0.01	2.08

Self-Regulation Practice

Hypothesis 5

This hypothesis stated that students would be able, over time, to improve their ability to assess their states of arousal as reflected in finger temperature guesses. Students exhibited a slight trend toward improvement in the ability to change their peripheral temperatures as the practice progressed. Figure 6 shows the results across the fifteen weeks of practice. While there were large variations in peripheral temperature, the general trend was upward, especially toward the end of the practice period. Furthermore, it was possible that there were external circumstances that explained some of the larger fluctuations. Data from the week before Thanksgiving (Week 3), for example, revealed a decline in peripheral temperature that may have been attributable to excitement prior to a holiday. More notably, there was a snowstorm (Week 6) that was accompanied by a sharp decline in the success of the students, and there was interfering ambient temperature (insufficient heat) during Week 8, causing a marked increase in the ability to change peripheral temperatures (see Observations 6 and 8 on Figure 6).

During the practice period, students continued to exhibit the ability to relax, as was measured by increases in their finger temperatures. This ability was quite consistent, regardless of whether it followed a relaxation exercise or an arousal exercise. The children were never

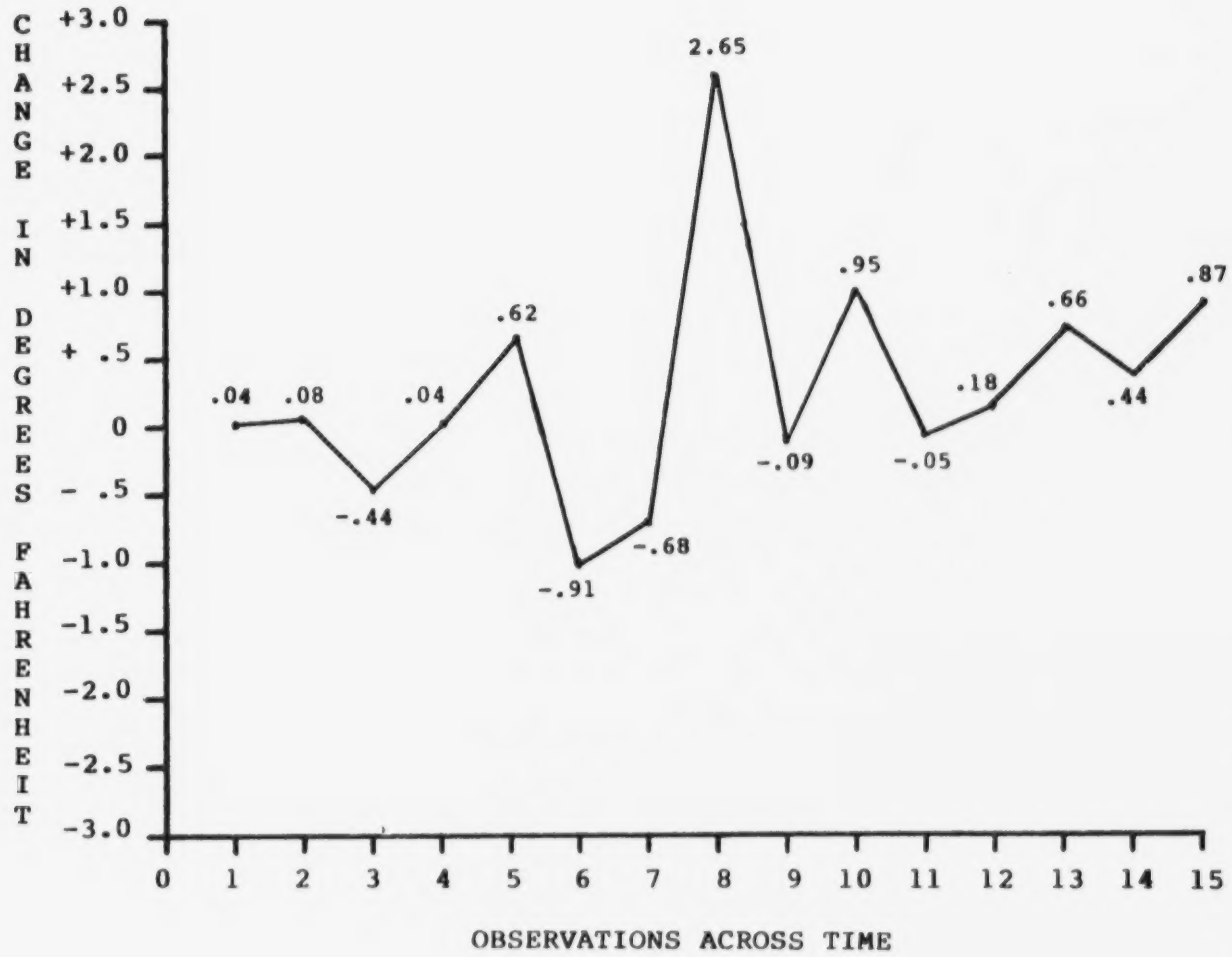

Figure 6. Success Rates of Students at Changing Finger Temperatures Across Weeks of Practice.

consistently successful in becoming stimulated. Thus, while students learned to induce the state of relaxation, they seemed to be incapable of evoking the state of arousal without assistance from a trainer. These results appear in Table 10, with positive scores indicating movement in degrees Fahrenheit in the intended direction and negative scores indicating movement away from the goal.

To determine which students successfully acquired the skill of changing their states of relaxation/arousal, the researcher observed the 27 students in each of 4 conditions that were determined by a combination of whether the students were trying to raise or lower their peripheral temperatures and whether they had just completed practice in relaxation or arousal. To be considered successful within each condition, a student had to change his or her temperature in the desired direction the majority of the time over repeated observations. To be considered successful overall, a student had to be successful in controlling temperature changes in 3 of the 4 conditions.

Thirteen of the 27 students were generally successful in changing temperatures, indicating that they had learned the skills necessary for self-regulation. Eight of these children were successful in 3 out of 4 conditions; 5 students were successful in all 4 conditions. Of the 8 students who were successful in 3 conditions, 7 students were unsuccessful in lowering their temperatures following arousal training.

Table 10

Success Rates of Students at Changing Peripheral Temperature During the Practice Period

Condition	After Relaxation		After Arousal	
	Mean	St. Dev.	Mean	St. Dev.
Trying to Become More Relaxed	0.83	2.08	0.87	2.75
Trying to Become More Aroused	-0.22	1.40	-0.88	2.28

It was clear that all of the students were successful in relaxing because both those students identified as successful and those who were not identified as such could raise their temperatures significantly (means of .42 and .48, respectively). However, while the successful students could lower their temperatures an average of .65 degrees, the unsuccessful students had an average of -.52, indicating that their temperatures actually rose.

Cognitive and Affective Measures

Hypothesis 6

Table 11 lists the tests in the thinking skills program in the order in which they were administered and contains the value of *t* that was calculated for each comparison. As indicated, there was no significant difference between the scores of the two groups on any of the first three tests. Beginning with the fourth test, the mean scores of the experimental group were significantly higher than the mean scores of the control group. The results indicated that, although the two groups did not differ on the early thinking skills tests, as training continued, the experimental group performed at a significantly higher level than did the control group.

Hypothesis 7

The researcher compared the performance of students in the experimental and control groups on each subtest of the Cognitive Abilities Test. As Table 12 reflects, in no case

Table 11

Comparison of Mean Scores on Each of the Teacher-Made Thinking Skills Tests

	Group[a]	Mean	St. Dev.	t	p
Verbal Classification	E	84.50	10.06	-1.016	.1572
	C	87.41	10.74		
Sentence Completion	E	67.73	16.16	1.393	.0848
	C	61.15	18.13		
Verbal Analogies	E	80.54	12.33	0.454	.3263
	C	79.07	11.16		
Quantitative Concepts	E	86.27	8.41	3.059	.0018*
	C	77.85	11.35		
Number Series	E	82.42	17.63	3.076	.0017*
	C	65.33	22.43		
Equation Building	E	86.96	7.49	3.566	.0005*
	C	76.81	12.66		
Figure Classification	E	98.65	2.31	8.599	.0001*
	C	83.48	8.86		
Figure Analogies	E	87.12	10.22	3.924	.0002*
	C	75.00	12.13		
Figure Analysis	E	88.35	12.19	2.240	.0148*
	C	81.22	10.95		

[a]E = Experimental Group and C = Control Group.

*$p < .05$.

Table 12

Comparison of Performance on the Cognitive Abilities Test

Test	Group[a]	Mean	St. Dev.	t	p
Verbal Classification	E	22.73	5.24	.9647	.1696
	C	21.22	6.09		
Sentence Completion	E	25.93	6.09	-.4586	.3243
	C	26.70	6.29		
Verbal Analogies	E	19.73	4.29	-.3334	.3701
	C	20.19	5.53		
Total Verbal	E	68.38	13.82	.0661	.4738
	C	68.11	16.17		
Quantitative Concepts	E	24.23	13.82	-.0613	.4757
	C	24.33	16.17		
Number Series	E	19.15	5.22	.0272	.4892
	C	19.11	6.17		
Equation Building	E	14.38	5.85	.3148	.3761
	C	13.96	3.59		
Total Quantitative	E	57.41	12.25	.0971	.4615
	C	57.77	12.87		
Figure Classification	E	21.65	4.43	.1966	.4225
	C	21.37	5.93		
Figure Analogies	E	23.31	5.99	.4173	.3391
	C	22.44	8.75		
Figure Analysis	E	14.19	4.10	.7855	.2179
	C	13.26	4.53		
Total Nonverbal	E	59.15	12.42	.5079	.3069
	C	57.07	16.95		

[a]E = Experimental Group and C = Control Group.

*$p < .05$.

was there a sig icant difference between the performance of the students in the two groups. The results indicated that the students in the experimental group did not perform on a higher level than did the students in the control group; thus, the null hypothesis of there being no difference between the groups had to be retained.

Hypothesis 8

Table 13 contains comparisons between mean scores for the experimental and control groups on the Coopersmith Self-Esteem Inventory. As indicated in the table, the responses of students in the experimental group resulted in significantly higher scores on the General Self and School-Academic subtests and on the total battery than did the responses of students in the control group. The differences between the groups on the other subtests were not significant, and in these instances, the null hypothesis was retained.

Hypothesis 9

Table 14 contains the results of the comparison of the mean scores of the experimental and control groups on the Nowicki-Strickland Locus of Control Scale for Children. The difference in the mean scores was not significant. The fact that students in the two groups did not differ on locus of control caused the null hypothesis of no difference between the groups to be retained.

Table 13

Comparison of Mean Scores on the Total Test and on Each Subtest of the Coopersmith Self-Esteem Inventory

Subtest	Group[a]	Mean	St. Dev.	t	p
General Self	E	23.35	1.72	4.480	.0001*
	C	19.59	3.98		
Social Self-Peers	E	6.58	1.39	-0.257	.3991
	C	6.67	1.14		
Home-Parents	E	7.12	.86	-1.480	.0723
	C	6.67	1.30		
School-Academic	E	6.58	1.53	1.910	.0309*
	C	5.74	1.65		
Total Test	E	87.23	7.53	3.310	.0010*
	C	77.33	13.52		

[a]E = Experimental Group and C = Control Group

*$p < .05$.

Table 14

Comparison of Mean Scores on the Nowicki-Strickland Locus of Control Scale for Children

Group	Mean	St. Dev.	t	p
Experimental	15.38	3.54	.3861	.3510
Control	15.00	3.70		

Hypothesis 10

Table 15 indicates that the students in the experimental group did not have a mean score on any of the scales of the Jesness Behavior Checklist that exceeded the mean score of the students in the control group. On two of the scales, Considerateness and Insight, the mean scores of the control group students exceeded those of the students in the experimental group. In no case was there rejection of the null hypothesis.

Hypothesis 11

Comparisons of the mean scores of the experimental and control groups on each of the five scales of the Child and Adolescent Adjustment Profile produced the results that are shown in Table 16. Only on the Productivity scale was there a significant difference in the scores of the two groups. On the Productivity scale, the control group obtained a higher rating than did the experimental group. Because it had been hypothesized that the experimental group would be rated higher on each of the subtests than the control group, it was necessary to retain the null hypothesis in every case.

Hypothesis 12

Ratings on the State-Trait Anxiety Inventory for Children yielded scores for both state anxiety and trait anxiety. Comparison of the scores of the experimental and control groups on both scales was via *t* tests. As Table 17 indicates, the

Table 15

Comparison of Mean Scores on the Jesness Behavior Checklist

Subscale	Group[a]	Mean	St. Dev.	t	p
Unobtrusiveness	E	31.50	6.85	-0.7916	.2162
	C	32.96	6.60		
Friendliness	E	19.38	3.78	0.1466	.4420
	C	19.22	4.25		
Responsibility	E	33.92	4.67	-1.0957	.1392
	C	35.59	6.27		
Considerateness	E	23.54	5.51	-2.1017	.0203*
	C	26.70	5.45		
Independence	E	17.46	2.73	0.8462	.2007
	C	16.81	2.83		
Rapport	E	17.38	3.76	-0.8410	.2022
	C	18.30	4.11		
Enthusiasm	E	18.73	3.68	-0.5362	.2971
	C	19.26	3.49		
Sociability	E	14.88	2.82	-1.1152	.1350
	C	15.78	3.00		
Conformity	E	28.77	3.41	-0.6718	.2524
	C	29.48	4.25		
Calmness	E	20.92	3.65	-0.5134	.3050
	C	21.52	4.70		
Effective Communication	E	18.08	5.02	-0.4385	.3315
	C	18.59	3.35		
Insight	E	23.38	3.76	-1.7270	.0451*
	C	25.22	3.98		
Social Control	E	16.38	3.19	-0.3583	.3608
	C	16.70	3.29		
Anger Control	E	13.31	3.80	-0.8845	.1903
	C	14.22	3.72		

[a]E = Experimental Group and C = Control Group

*$p < .05$.

Table 16

Comparison of Mean Scores on the Five Scales of the Child and Adolescent Adjustment Profile

Scale	Group[a]	Mean	St. Dev.	t	p
Peer Relations	E	13.19	1.10	-0.2727	.3931
	C	13.30	1.64		
Dependency	E	6.77	1.89	-0.7085	.2410
	C	7.11	1.63		
Hostility	E	5.85	1.91	-0.7631	.2245
	C	6.22	1.67		
Productivity	E	11.35	2.48	-2.0600	.0223*
	C	12.70	2.32		
Withdrawal	E	6.73	1.59	0.1618	.4358
	C	6.67	1.27		

[a]E = Experimental Group and C = Control Group

*$p < .05$.

Table 17

Comparison of Mean Scores on Scales of the State-Trait Anxiety Inventory for Children

Scale	Group[a]	Mean	St. Dev.	t	p
State Anxiety	E	28.38	3.63	2.3300	.0244*
	C	31.52	5.92		
Trait Anxiety	E	36.31	6.66	-0.4323	.6673
	C	35.59	5.33		

[a]E = Experimental Group and C = Control Group.

*$p < .05$.

mean scores of the experimental group were significantly lower on the state anxiety scale than were the scores of the control group, but the mean scores of the two groups on the trait anxiety scale did not differ significantly. The results indicated that, following the training program, the experimental group reported a lower level of state anxiety than did the control group, but the two groups reported similar levels of trait anxiety.

DISCUSSION

The self-regulation training to teach students the skills needed to increase levels of relaxation and arousal was impressively successful, as measured by peripheral temperatures, at least as long as the trainer worked with the whole group. However, when students tried to employ the procedures individually and silently in their seats, they were only able to relax at will; about half of the students never learned to elicit arousal. Perhaps the lack of developed materials on arousal and the lack of experience of the trainer with arousal techniques made the arousal training less operative than the relaxation training. It seemed likely, also, that it was simply difficult for students to sit passively in a chair and grow increasingly stimulated. Students improved both relaxation and arousal

skills somewhat with time, indicating that self-regulation may be a skill that requires considerable practice in order to achieve rapid, measurable change.

Learning self-regulation skills allows a person to analyze his or her state and to adjust it to an appropriate level for a given situation. When taking a test, an individual must be alert, yet calm. Thus, when faced with a testing situation, a person who is skilled in self-regulation should be able to raise his or her level of arousal or relaxation, if necessary. Likewise, persons who practice self-regulation should be able to outperform others on tests simply by adjusting their mental states. Although the students in the experimental group generally outperformed students in the control group on a series of teacher-made achievement tests, there was no difference between the two groups on the standardized Cognitive Abilities Test given at the end of the instructional program. One reason for this result may be that the students never actually learned to elicit arousal. The relaxation skills of the students in this study were good; however, such skills were useful only for students with anxiety regarding tests or classroom performance. Other students needed to increase their levels of arousal to ensure that they were alert and mentally sharp when taking a test or performing in the class. Another reason may be that the students failed to make the connection between self-regulation skills that were taught away from

the school and the activities that occurred in the classroom. Some students who learned self-regulation skills, apparently did not use these skills habitually in the regular school setting.

Although the self-regulation trainer observed much positive improvement in the behavior of the experimental children from the beginning to the ending of the school year, the responses of the children on the Jesness Behavior Checklist showed no significant differences between the two groups. One explanation for the improvement in behavior not showing in the responses to the questionnaire is that the control group may have matured and changed their behavior at approximately the same rate as the experimental children. Also, the experimental group seemed to master the technique of self-assessment; in turn, that mastery gave them enough confidence to respond to the instrument and note rather harshly their own inappropriate behavior. The control group, on the other hand, failed to be as perceptive of their behavior. Teachers, serving as raters, failed to see differences between the groups on the Child and Adolescent Adjustment Profile. These findings disagree with previous research (Matthews, 1986a; Dunn & Howell, 1982; Gerler & Omizo, 1981; Oldfield, 1986).

Self-regulation directly affects self-esteem. Students who practiced relaxation and arousal exercises learned tangibly that they were largely in control of their bodies

and minds. This knowledge had a significant impact on how these students viewed themselves. The experimental group had significantly higher overall scores on self-esteem, as well as in the subtest areas of General Self and School-Academic, than did the control group.

Self-regulation is beneficial to students in lowering perceived anxiety levels. The results of analyses indicated that the subjects in the experimental group reported lower levels of state anxiety following the training program than did the subjects in the control group. There was no significant difference between the two groups on the level of trait anxiety. Theoretically, state anxiety is a situational characteristic and trait anxiety is a part of the basic personality of an individual. Therefore, a program designed to train students in relaxation techniques should affect the level of situational (state) anxiety but should affect the level of trait anxiety very little. The findings relative to anxiety were consistent with the expected effect.

Teaching students stress management skills, such as relaxation and arousal, is clearly beneficial and worthwhile because practicing such self-regulation skills raises self-esteem and lowers anxiety. In theory, it seems that possessing self-regulation skills could improve the achievement of students; unfortunately, this has not been the case so far in practice. Perhaps sixth and seventh grade students have not reached a mental level of development

sufficient to grasp complex relationships among abstract concepts. The connection between the abstract ideas concerning internal arousal or relaxation states and such real-world events as studying and taking tests may be difficult for students of this level. Also, self-regulation may affect academic performance only over a very long period. Although the connection between self-regulation and achievement is not supported by this research, there are numerous avenues left to be explored in future research.

Whether or not schools should adopt relaxation/arousal training as another tool in educating students must be left to the schools to decide. The training takes valuable time, and it is not clear yet that it would necessarily improve achievement levels for this age group. It is not apparent at this time the part that self-induced arousal plays in the achievement of students without external direction. The study did not indicate significant numbers of students mastering the skills. However, self-regulation training can be a valuable tool in improving the perceptions of students about themselves and, perhaps, as part of a holistic health and education program, in helping students develop and carry through to adulthood coping skills for use in a variety of academic and personal situations.

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APPENDIX A

OBJECTIVES FOR THE SELF-REGULATION CURRICULUM

1. To develop an understanding of the concept of wellness (quality versus quantity of life).
2. To develop an understanding of the autonomic nervous system and the role of the parasympathetic and sympathetic divisions.
3. To become acquainted with the general adaptation syndrome and the emergency and quieting reflexes.
4. To become aware of the mind/body connection.
5. To become familiar with biofeedback: electroencephalogram (EEG), galvanic skin response (GSR), and peripheral temperature.
6. To measure bodily responses to various imaginary scenes (peaceful, scary, disappointing, restful, etc.).
7. To recognize individual differences in responding to stressors in daily living.
8. To develop an understanding of the various personality types: A, B, and C.
9. To discriminate between positive and negative alerts of the body.
10. To become aware of changes in the physical body with various mental states.
11. To identify methods that a person may use to change from one mental state to another.

12. To match the activity with the appropriate bodily state (high arousal, medium arousal, low arousal, etc.).
13. To develop an understanding of the concept of homeostasis.
14. To develop skill in techniques of relaxation and arousal by using:
    a. imagery
    b. progressive relaxation
    c. breathing
    d. autogenics
    e. quieting response
    f. calisthenics
    g. self-messages
    h. stretching exercises
    i. sittercises
15. To develop self-regulation skills in order to change from one mental state to another.
16. To develop knowledge about the functioning of the brain in relationship to neurotransmitters.
17. To develop an understanding of the role of negative and positive thoughts in stress management.
18. To identify descriptive words that are strong, weak, or neutral with regard to emotions.
19. To develop skills for assessing the cues of the body for various states along the relaxation/arousal continuum.
20. To develop a self-awareness of the state for peak performance along the relaxation/arousal continuum.

APPENDIX B

REFERENCE LIST FOR SELF-REGULATION TRAINING

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APPENDIX C

TEMPERATURE RECORDING FORMS

Rested State

NAME _____ DATE _____

TEMPERATURE (GUESS) _____ TEMPERATURE (AMBIENT) _____

TEMPERATURE 1 (ACTUAL) _____ 10 SECONDS

TEMPERATURE 2 (ACTUAL) _____ 2 MINUTES

Relaxed State

NAME _____ DATE _____

TEMPERATURE (GUESS) _____ TEMPERATURE (AMBIENT) _____

TEMPERATURE 1 (ACTUAL) _____ 10 SECONDS

TEMPERATURE 2 (ACTUAL) _____ 2 MINUTES

Aroused State

NAME _____ DATE _____

TEMPERATURE (GUESS) _____ TEMPERATURE (AMBIENT) _____

TEMPERATURE 1 (ACTUAL) _____ 10 SECONDS

TEMPERATURE 2 (ACTUAL) _____ 2 MINUTES

APPENDIX D

REFERENCE LIST FOR THINKING SKILLS INSTRUCTION

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APPENDIX E

LESSON PLAN 5--NUMBER SERIES

DAY 1

1. The student will be able to demonstrate proficiency in number series.

    1.1 Learning Activities.

        1.1.1 Introduce numbers coming one after another by the process of addition, subtraction, multiplication, or division.

            1.1.1.1 Display 4 flash cards showing the formation of a number series.

                1.1.1.1.1 Addition.
                1.1.1.1.2 Subtraction.
                1.1.1.1.3 Multiplication.
                1.1.1.1.4 Division.

            1.1.1.2 Display poster with three number series for students to identify the pattern.

            1.1.1.3 Read and discuss Activity 1 (Student Booklet).

            1.1.1.4 Assign written material.

                1.1.1.4.1 Activity 2 (Student Booklet).

            1.1.1.5 Assign enrichment material.

                1.1.1.5.1 Activity 3 (Student Booklet).

Day 2

            1.1.1.6 Review/check activities from Day 1.

            1.1.1.7 Introduce and assign written material.

                1.1.1.7.1 Activities 4 and 5 (Student Booklet).

1.1.1.8 Assign enrichment material.

1.1.1.8.1 Activity 6 (Student Booklet).

Day 3

1.1.1.9 Review/check activities from Day 2.

1.1.1.10 Introduce and assign written material.

1.1.1.10.1 Activities 7 and 8 (Student Booklet).

1.1.1.11 Assign enrichment material.

1.1.1.11.1 Activity 9 (Student Booklet).

Day 4

1.1.1.12 Review any activities not checked.

1.2 Evaluation.

1.2.1 Administer test on number series.

APPENDIX F

STUDENT BOOKLET

NUMBER SERIES

NAME _____

NAME _____ DATE _____

ACTIVITY 1

A **series** is a group of numbers given in a specified order, according to some rule. Three periods (...) mean and so on.

Series: 5, 8, 11, 14, ...

add 3 add 3 add 3

Rule: Add 3 to each number to get the next number in the series.

The next 3 numbers in the series are 17, 20, and 23.

A. Find the rule for the series.

1. 1, 4, 7, 10, 13, ...

2. 1, 3, 9, 27, ...

B. Find the number which fits the series.

Example **Series:** 1, 2, 4, 8, __?__, 32

Rule: Multiply each number by 2 to get the next number in the series.

The number 16 fits the series.

3. 3, 9, 27, 81, _____

4. 95, 85, 75, ____, 55

C. The rule for a series can follow a pattern. Find the next 3 numbers in the series.

Example **Series:** 1, 3, 6, 10, ...

add 2 add 3 add 4

Rule: Add 2 to the first number, add 3 to the next number, add 4 to the third number, and so on.

The next 3 numbers are 15, 21, and 28.

5. 1, 3, 6, 10, 15, ...

6. 2, 2, 4, 12, 48, ...

D. Sometimes a series has 2 rules. Find the next 3 numbers in the series.

Example **Series:** 4, 5, 7, 8, 10, ...

Rule: Add 1 to the first number, add 2 to the next number, add 1 to the next number, and so on.

The next 3 numbers are 11, 13, and 14.

7. 5, 10, 11, 16, 17, ...

8. 2, 4, 5, 10, 11, ...

NAME _____ DATE _____

ACTIVITY 2

DIRECTIONS: List the next three numbers in the pattern.

1.	Add 3.	1, 4, 7, 10, ___, ___, ___
2.	Add 4.	2, 6, 10, 14, ___, ___, ___
3.	Add 6.	3, 9, 15, 21, ___, ___, ___
4.	Add 9.	9, 18, 27, 36, ___, ___, ___
5.	Multiply by 4.	1, 4, ___, ___, ___
6.	Multiply by 5.	1, 5, ___, ___, ___
7.	Complete the pattern.	5, 10, 15, 20, ___, ___, ___
8.	Complete the pattern.	1, 3, 9, 27, ___, ___, ___
9.	Complete the pattern.	6, 14, 22, 30, ___, ___, ___
10.	Multiply by 2. Then subtract 1.	3, 5, 9, ___, ___, ___
11.	Subtract 1. Then multiply by 2.	3, 4, 6, ___, ___, ___
12.	Multiply by 6. Then subtract 4.	1, 2, 8, ___, ___, ___

Follow the directions, digit by digit, to complete the number series.

13. Decrease by 2 each time, going from left to right.

    9 ___ ___ ___ ___

14. Increase by 3 until you reach 8. Then decrease by 3.

    2 ___ ___ ___ ___

15. Decrease by 4 until you reach 1. Then increase by 4.

    9 ___ ___ ___ ___

16. Add all preceding digits to get the next digit.

    1 ___ ___ ___ ___

Continue the pattern by finding the next three numbers.

17.
$1 \times 1 = 1$
$2 \times 2 = 4$
$3 \times 3 = 9$
$4 \times 4 = 16$
$__ \times __ = __$
$__ \times __ = __$
$__ \times __ = __$

18.
$1 + 2 = 3$
$3 + 4 = 7$
$5 + 6 = 11$
$7 + 8 = 15$
$__ + __ = __$
$__ + __ = __$
$__ + __ = __$

19.
$1 \times 2 = 2$
$2 \times 3 = 6$
$3 \times 4 = 12$
$4 \times 5 = 20$
$__ \times __ = __$
$__ \times __ = __$
$__ \times __ = __$

20.
$1 = 1$
$1 + 3 = 4$
$1 + 3 + 5 = 9$
$1 + 3 + 5 + 7 = 16$
$__ + __ + __ + __ + __ = __$
$__ + __ + __ + __ + __ + __ = __$
$__ + __ + __ + __ + __ + __ + __ = __$

21.
$1 = 1$
$1 \times 2 = 2$
$1 \times 2 \times 3 = 6$
$1 \times 2 \times 3 \times 4 = 24$
$__ \times __ \times __ \times __ \times __ = __$
$__ \times __ \times __ \times __ \times __ \times __ = __$
$__ \times __ \times __ \times __ \times __ \times __ = __$

NAME _____ DATE _____

ACTIVITY 3 (Enrichment)

DIRECTIONS: Find the next two numbers in each series.

1. 15, 30, 45, 60, ____, ____

2. 55, 50, 45, 40, ____, ____

3. 3, 18, 108, 648, ____, ____

4. 1, 38, 75, 112, ____, ____

5. 10, 50, 250, 1250, ____, ____

6. 17, 21, 25, 29, ____, ____

7. 256, 128, 64, 32, ____, ____

8. 94, 83, 72, 61, ____, ____

9. 7, 9, 8, 10, 9, 11, ____, ____

10. 20, 23, 19, 22, 18, 21, ____, ____

11. 10, 11, 9, 10, 8, 9, ____, ____

12. 50, 40, 45, 35, 40, 30, ____, ____

13. 1, 6, 4, 9, 7, 12, ____, ____

14. 64, 68, 66, 70, 68, 72, ____, ____

15. 32, 36, 42, 46, 52, 56, ____, ____

16. 75, 67, 60, 52, 45, 37, ____, ____

NAME _____ DATE _____

ACTIVITY 4

DIRECTIONS: Find the rule for the series.

1. 2, 7, 12, 17, 22, _____

2. 3, 9, 15, 21, 27, _____

3. 3, 6, 9, 12, _____

4. 1, 4, 16, 64, _____

DIRECTIONS: Find the number which fits the series.

1. 2, 12, 22, 32, ____

2. 41, 39, 37, ____, 33

3. 0, 4, 8, 12, ____

4. 48, 24, 12, 6, ____

5. 5, 7, 11, 17, ____

6. 0, 3, 7, ____, 18

7. 1, 1, 2, 6, 24, ____

8. 100, 98, 94, 88, 80, ____

9. 6, 7, 5, 6, 4, ____

10. 1, 3, 6, 8, 16, ____

11. 1, 2, 6, 7, 21, ____

12. 10, 20, 15, 25, 20, ____

DIRECTIONS: Find the next 3 numbers in the series.

1. 2, 4, 4, 8, 8, ____, ____, ____

2. 10, 20, 25, 35, 40, ____, ____, ____

3. 100, 98, 98, 96, 96, ____, ____, ____

4. 89, 80, 71, 62, 53, ____, ____, ____

NAME _____ DATE _____

ACTIVITY 5

DIRECTIONS: Discover the pattern. Name the next number.

1. 2, 4, 8, 16, 32, ____
2. 3, 7, 11, 15, 19, ____
3. 1, 4, 9, 16, 25, ____
4. 15, 12, 9, 6, 3, ____
5. 7, 6, 12, 11, 22, ____
6. 4, 8, 6, 12, 10, ____
7. 4, 10, 16, 22, 28, ____
8. 2, 8, 10, 40, 42, ____
9. 4, 13, 22, 31, 40, ____
10. 32, 28, 24, 20, 16, ____
11. 18, 13, 9, 6, 4, ____
12. 6, 6, 7, 9, 9, ____
13. 12, 15, 21, 30, 33, ____
14. 8, 7, 9, 6, 10, ____
15. 6, 12, 24, 48, ____

Brainteaser

This grouping of numbers is called Pascal's Triangle. Discover the pattern and find rows 6 and 7 of Pascal's Triangle.

row 1 1

row 2 1 1

row 3 1 2 1

row 4 1 3 3 1

row 5 1 4 6 4 1

row 6

row 7

NAME _____ DATE _____

ACTIVITY 6 (Enrichment)

DIRECTIONS: Find the next 3 numbers in each series.

1. 3, 13, 10, 20, 17, ____, ____, ____

2. 3, 5, 9, 15, 23, ____, ____, ____

3. 62, 58, 54, 50, 46, ____, ____, ____

4. 4, 14, 24, 34, 44, ____, ____, ____

5. 4, 6, 10, 16, 24, ____, ____, ____

6. 41, 37, 33, 29, 25, ____, ____, ____

7. 5, 15, 45, 135, 405, ____, ____, ____

8. 75, 65, 55, 45, 35, ____, ____, ____

9. 4, 5, 15, 16, 48, ____, ____, ____

10. 2, 10, 6, 30, 26, ____, ____, ____

11. 2, 5, 10, 17, 26, ____, ____, ____

12. 3, 11, 19, 27, 35, ____, ____, ____

NAME _____ DATE _____

ACTIVITY 7

DIRECTIONS: List the next number in the series.

1. $\frac{1}{3}, \frac{2}{3}, \frac{4}{3}, \frac{8}{3}, \frac{16}{3}, ____$

2. $\frac{1}{2}, \frac{2}{3}, \frac{3}{4}, \frac{4}{5}, \frac{5}{6}, ____$

3. 25, 21, 24, 20, 23, ____

4. $\frac{11}{12}, \frac{9}{10}, \frac{7}{8}, \frac{5}{6}, \frac{3}{4}, ____$

5. 18, 11, 17, 12, 16, ____

6. 5, 6, 8, 11, 15, ____

7. 3, 6, 18, 36, 108, ____

8. 3, 2, 4, 3, 6, ____

9. 29, 38, 47, 56, 65, ____

10. 4, 4, 5, 5, 6, ____

11. 6, 9, 7, 10, 8, ____

12. 3, 5, 4, 7, 5, ____

13. 16, 18, 36, 38, 76, ____

14. 9, 19, 24, 34, 39, ____

15. 2, 2, 4, 12, 48, ____

NAME _____ DATE _____

ACTIVITY 8

DIRECTIONS: Discover the pattern. Name the next number.

1. 84, 82, 82, 80, 80, ____

2. $\frac{13}{24}$, $\frac{12}{25}$, $\frac{11}{26}$, $\frac{10}{27}$, $\frac{9}{28}$, ____

3. 14, 15, 13, 14, 12, ____

4. 9, 11, 33, 35, 105, ____

5. 6, 8, 16, 18, 36, ____

6. 2, 3, 4, 2, 0, 3, ____

7. 7, 7, 8, 10, 10, ____

8. 5, 10, 20, 4, 8, 16, 3, ____

9. 7200, 3600, 1200, 300, 60, ____

10. 13, 16, 19, 22, 25, ____

11. 27, 27, 29, 33, 33, 35, ____

12. 7, 15, 31, 63, 127, ____

13. 10, 12, 15, 19, 24, 30, ____

14. 24, 12, 36, 18, 54, ____

15. 58, 52, 47, 43, 40, ____

NAME _____ DATE _____

ACTIVITY 9 (Enrichment)

DIRECTIONS: Find the numbers which fit the series.

1. 60, ____, ____, 42, 36

2. ____, 90, 81, 72, 63

3. ____, 20, 24, 28, 32

4. 15, ____, ____, 120, 240

5. 10, ____, ____, 19, 22

6. 25, ____, ____, 1600, 6400

7. 37, ____, 27, ____, 17

8. 2, ____, 6, 12, 14, ____

9. 11, ____, 12, 10, 13, ____

APPENDIX G

NAME _____ DATE _____

TEST 5--NUMBER SERIES

I. DIRECTIONS: Write the number which fits the series.

1. 3, 13, 23, 33, ____

2. 4, 9, 14, 19, ____

3. 16, 14, 12, 10, ____

4. 36, 39, 42, 45, ____

5. 73, 67, 61, 55, ____

6. 0, 2, 6, 12, 20, ____

7. 68, 56, 44, 32, 20, ____

8. 23, 27, 31, 35, 39, ____

9. 105, 90, 75, 60, 45, ____

10. 87, 79, 71, 63, 55, ____

II. DIRECTIONS: Find the next 3 numbers in the series.

1. 8, 16, 16, 32, 32, ____, ____, ____

2. 7, 8, 16, 17, 34, ____, ____, ____

3. 10, 13, 17, 22, 28, ____, ____, ____

4. 15, 60, 240, 960, 3840, _____, _____, _____

5. 3, 5, 10, 12, 24, 26, ____, ____, ____

III. **DIRECTIONS: Write the number which fits the series.**

1. 27, 9, 18, 36, 12, ____

2. 59, 52, 46, 41, 37, ____

3. 13, 26, 28, 56, 58, ____

4. 72, 63, 63, 54, 54, ____

5. 36, 35, 70, 69, 138, ____

6. 78, 78, 79, 79, 80, ____

7. 17, 85, 81, 405, 401, ____

8. 96, 48, 144, 72, 216, ____

9. 10, 13, 9, 14, 8, ____

10. $\frac{6}{11}$, $\frac{5}{12}$, $\frac{4}{13}$, $\frac{3}{14}$, $\frac{2}{15}$, ____

11. $\frac{14}{17}$, $\frac{12}{15}$, $\frac{10}{13}$, $\frac{8}{11}$, $\frac{6}{9}$, ____

IV. **DIRECTIONS: Write the missing numbers which fit the series.**

1. 14, ____, ____, 26, 30

2. 37, ____, ____, 13, 5

3. ____, 15, 20, ____, 35

4. 3, ____, ____, 15, 23